

## **Final Mitigation Plan for Heated Pond Evaporative Losses under Permit 37-8205**

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This mitigation plan is based on 1) revised and updated meteorological data, and 2) consumptive volume provided by reduction of acreage within the Clarendon reservoir as agreed to by IDWR.

### **A. Hailey-Clarendon Weather Data Comparison**

A comparison was made between the Hailey airport station and the Clarendon weather station for temperature, relative humidity, and wind speed. Daily average data for these parameters were calculated for the overlap period of August 5, 2011 through October 31, 2012. Scatterplots indicate that temperature and relative humidity are nearly the same between the two stations. Wind speed, however, is very different. It is almost always lower at Clarendon and no significant correlation exists between the two stations ( $R^2 = 0.041$ ). The wind speed data was further analyzed by calculating monthly averages and comparing the two stations. Unlike the daily data, the monthly average data indicates a moderate correlation with an  $R^2$  of 0.448.

From this analysis, it appears reasonable to use the Hailey station for temperature and relative humidity, taking advantage of its lengthy period of record for temperature. Temperature is from the NWS station with a period of record 1893-1988. Relative humidity is from the airport station for the period 2003-2012 (the previous record of 2007-2009, used for previous submittals, was augmented for this analysis).

For the wind speed, two possible approaches could be taken:

1. Even though the record is short, the Clarendon station daily data could be used to calculate monthly wind speed, since orographic effects clearly cause differing daily wind patterns at this location compared to Hailey.
2. The regression equation for monthly averages could be used to estimate the monthly average wind speed at Clarendon from the corresponding value at Hailey. Since the evaporation calculations were performed on a monthly, not daily, basis, this approach appears reasonable.

## **B. Revised Evaporation Calculations**

The evaporation calculations described in previous reports, using the same four (4) analytical methods, were re-run using the Hailey station for temperature and relative humidity, and the two approaches described above for wind speed at Clarendon. It was found that virtually equivalent results were obtained whether method 1 or 2 was used. Therefore, only method 2 is reported here.

Evaporation of a cold-water pond was calculated to be 20.82 inches or 1.74 ac-ft/acre. The Allen & Robison (2012) value for shallow pond systems at the Hailey station is 30.8 inches. The difference can reasonably be attributed to the significantly lower wind speed prevailing at Clarendon.

### **1) Consumptive Mitigation Available**

Previous analysis submitted to the Department for the November 23, 2010 mitigation plan has shown that the historical surface area of the Clarendon reservoir was 14.0 acres. The maps used to support this number are included herein. The acreage stipulated to in a transfer proceeding in 2001 was 13.13 acres, which is the area IDWR has agreed to utilize as a baseline. The current area is 11.8 acres, or a reduction of 1.33 acres from the baseline. A reduction of 1.33 acres is equivalent to 2.31 ac-ft per year of evaporation using the cold-water evaporation value of 20.82 inches. This is the amount of consumptive mitigation available from the reservoir surface area reduction. The mitigation volume will be provided by existing water right 37-4369.

### **2) Heated Pond Evaporation Increase**

By trial using the attached evaporation calculation spreadsheets, it was found that the temperature of the pond can be held constant at 62 degrees F and the temperature of the plunge can be 85 degree F without the evaporation increase exceeding the available consumptive mitigation volume of 2.31 ac-ft/year. Total evaporation is calculated to be 4.15 ac-ft/year or an increase of 2.12 ac-ft/year over an equivalent-size cold water pond. Therefore, it is proposed to limit the temperature to this constant level, or to a seasonal temperature pattern which results in no more than 2.31 ac-ft/year of evaporation increase.

## **C. Reservoir Volume**

The reservoir volume has, like the surface area, been reduced from its historic volume of at least 130 acre-feet. However, IDWR has agreed to a baseline of 102.4 acre-feet, the volume under 37-4369 stipulated to in the 2001 transfer. From a hydrologic standpoint, decreasing the allowed storage volume as a means of mitigating real losses from the system would not be effective in this case since the reservoir is a “flow-through” system which is kept full continuously. Thus, the only real consumptive depletion each year is

from evaporation; no depletion from refill occurs. However, if the Department believes a reduction from 102.4 ac-ft is necessary to mitigate for permit 37-8205, the permittee agrees to reduce the storage volume on water right 37-4369 by 2.31 ac-ft to 100.1 acre-feet.

#### **D. Revised Annual Volume and Flow Rate Requirement**

Peak flow and monthly volume calculations are provided on the attached spreadsheets. These calculations follow the same methodology as those in the original beneficial use examination, but using the new meteorological data as described above. Recall that the peak flow was calculated assuming an air temperature of -1.7 F, which is the 80% exceedance minimum daily temperature at Hailey. Monthly volumes were calculated by using the average monthly inputs. The following results were obtained:

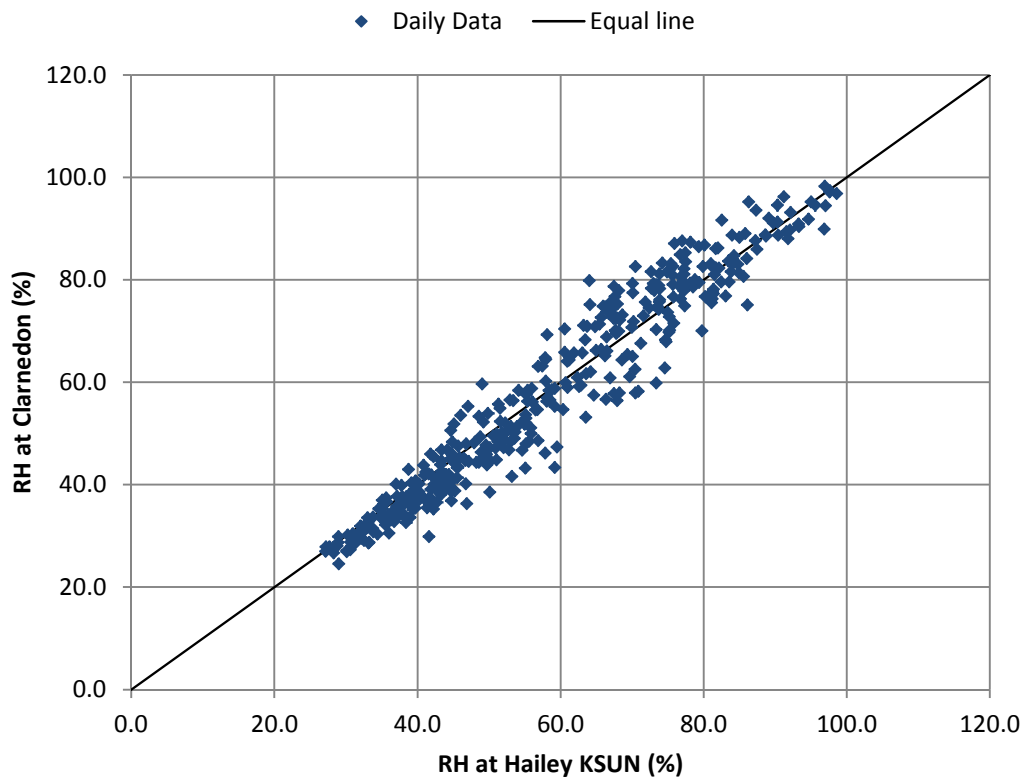
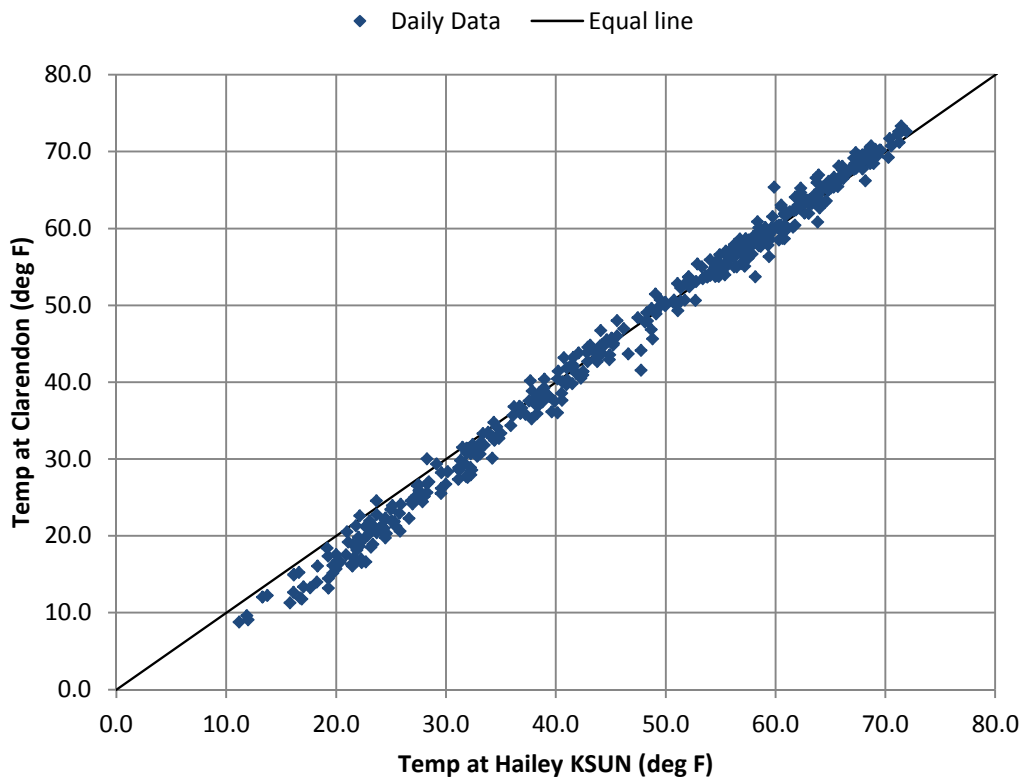
Peak flow requirement        164 gpm (0.37 cfs)  
Annual volume requirement   154.0 ac-ft

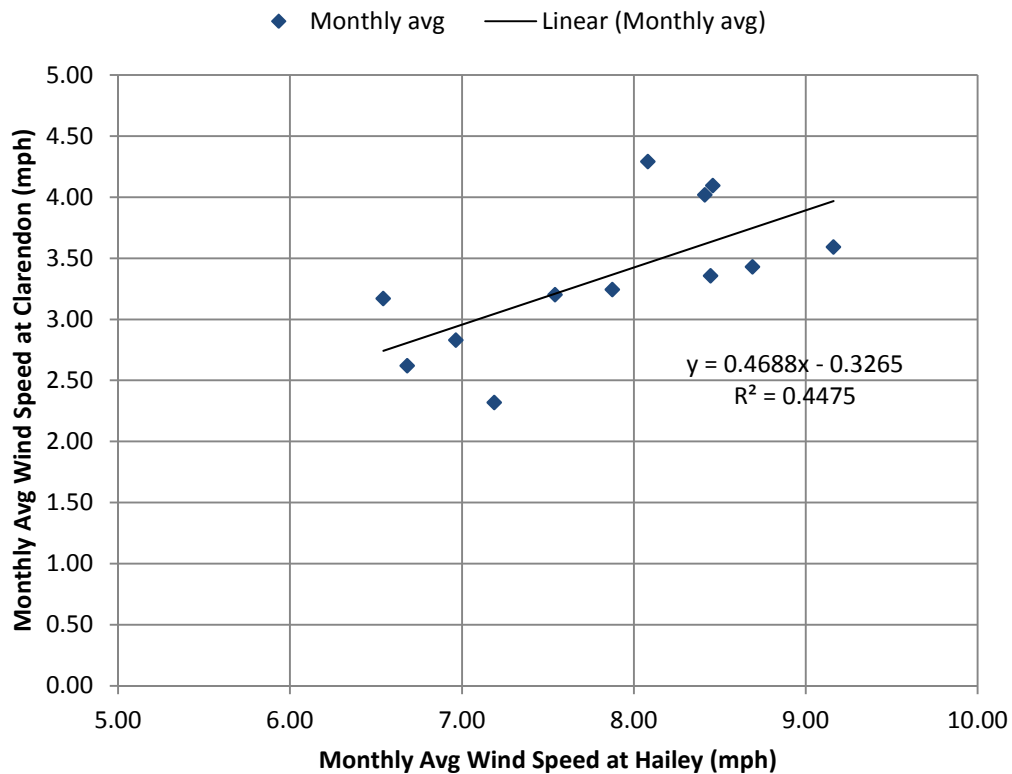
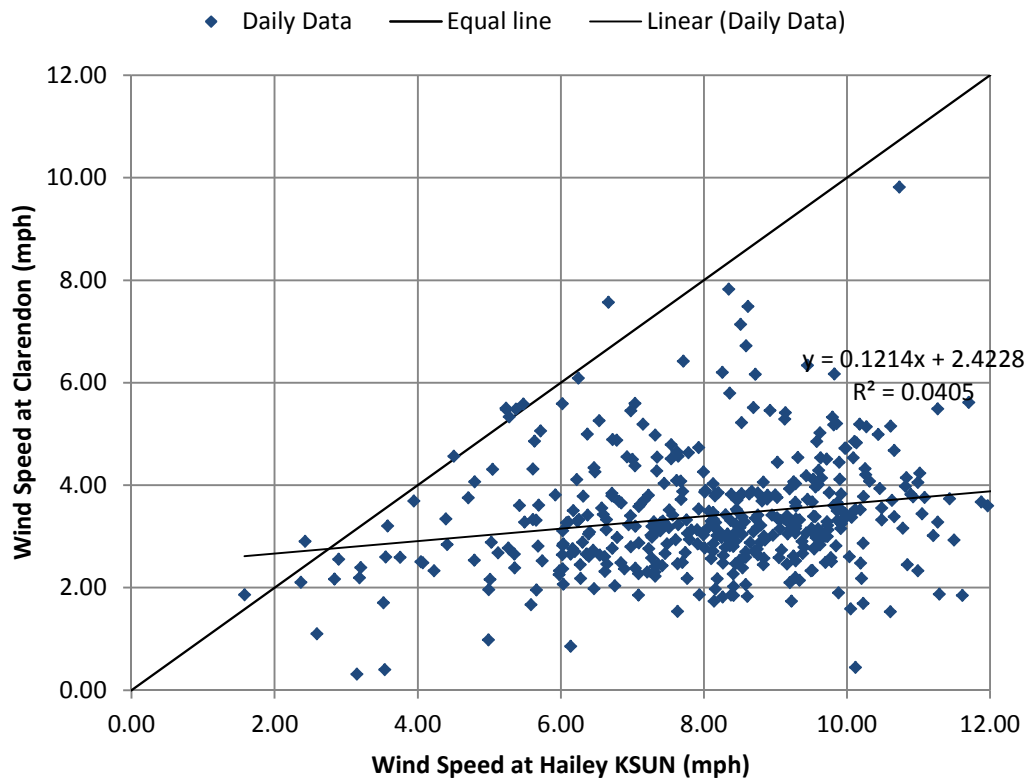
#### **E. Recommended Amounts for Licensing**

For licensing purposes, the flow and volume requirements for residential and snowmelting purposes have not changed, but the flow and volume for heating of the pond/spa should reflect the above amounts. The recommended amounts to be licensed are as follows:

|                                    | Div. Rate       | Ann. Volume      |
|------------------------------------|-----------------|------------------|
| Heating (residential)              | 0.032 cfs       | 17.4 afa         |
| Heating (snowmelting)              | 0.81 cfs        | 104.7 afa        |
| Recreation or Heating (pond / spa) | 0.37 cfs        | 154.0 afa        |
| <b>TOTAL</b>                       | <b>1.21 cfs</b> | <b>276.1 afa</b> |

## Comparison of Hailey and Clarendon Weather Data, August 2011 - October 2012





## Monthly Average Wind Speed at Clarendon Predicted with Hailey Averages

KSUN monthly average 1996-2006

Clarendon monthly average estimated by regression with KSUN:

Clarendon =  $0.4688 * \text{Hailey} - 0.3265$

| Month     | KSUN-Hailey<br>(mph) | Clarendon<br>(mph) | Clarendon<br>(m/s) |
|-----------|----------------------|--------------------|--------------------|
| January   | 4.1                  | 1.60               | 0.71               |
| February  | 4.6                  | 1.83               | 0.82               |
| March     | 5.9                  | 2.44               | 1.09               |
| April     | 6.7                  | 2.81               | 1.26               |
| May       | 7.6                  | 3.24               | 1.45               |
| June      | 7.7                  | 3.28               | 1.47               |
| July      | 8.1                  | 3.47               | 1.55               |
| August    | 7.9                  | 3.38               | 1.51               |
| September | 7.5                  | 3.19               | 1.43               |
| October   | 6.4                  | 2.67               | 1.20               |
| November  | 4.5                  | 1.78               | 0.80               |
| December  | 3.9                  | 1.50               | 0.67               |

# EVAPORATIVE LOSS IN OUTDOOR POOL - NATURAL COLD WATER CONDITIONS

Four applicable methods as compiled by Helfrich et al. (1982), reported and discussed in Bras (1990)  
CGB REVISED 1/30/2013

Air temperature: Hailey NWS station, 1893-1988 period

Relative humidity: Hailey airport station, 2003-2012 period

Wind speed: Clarendon station, August 2011-October 2012 period

Pond temperature 9999 deg C (9999 = natural flow temp)

a 2500 J/g

b 2.386 J/g-C

rho 1.00E+06 g/m^3

a,b are coeffs in Le equation:

Le = a - bT

rho = density of water

es = saturation vapor pressure at pond surface temperature

ea = vapor pressure of ambient air

| Month     | Days | Avg air temp [C] | Avg RH (%) | Avg Wind (m/s) | Pond sfc temp [C] | Le [J/g] | es (mb) | ea (mb) | Est. pond temp (natural flow) |      |
|-----------|------|------------------|------------|----------------|-------------------|----------|---------|---------|-------------------------------|------|
|           |      |                  |            |                |                   |          |         |         | F                             | C    |
| January   | 31   | -7.1             | 76         | 0.71           | 4.4               | 2489     | 8.4     | 2.8     | 40                            | 4.4  |
| February  | 28   | -4.4             | 73         | 0.82           | 4.4               | 2489     | 8.4     | 3.2     | 40                            | 4.4  |
| March     | 31   | -0.6             | 68         | 1.09           | 4.4               | 2489     | 8.4     | 4.0     | 40                            | 4.4  |
| April     | 30   | 5.9              | 60         | 1.26           | 7.2               | 2483     | 10.2    | 5.6     | 45                            | 7.2  |
| May       | 31   | 10.9             | 58         | 1.45           | 10.0              | 2476     | 12.3    | 7.6     | 50                            | 10.0 |
| June      | 30   | 14.9             | 53         | 1.47           | 12.8              | 2470     | 14.8    | 8.9     | 55                            | 12.8 |
| July      | 31   | 19.7             | 40         | 1.55           | 18.3              | 2456     | 21.1    | 9.3     | 65                            | 18.3 |
| August    | 31   | 18.9             | 41         | 1.51           | 18.3              | 2456     | 21.1    | 8.9     | 65                            | 18.3 |
| September | 30   | 13.7             | 48         | 1.43           | 12.8              | 2470     | 14.8    | 7.6     | 55                            | 12.8 |
| October   | 31   | 8.1              | 63         | 1.20           | 7.2               | 2483     | 10.2    | 6.8     | 45                            | 7.2  |
| November  | 30   | 0.6              | 72         | 0.80           | 4.4               | 2489     | 8.4     | 4.6     | 40                            | 4.4  |
| December  | 31   | -5.4             | 78         | 0.67           | 4.4               | 2489     | 8.4     | 3.2     | 40                            | 4.4  |

|           | Kohler (1954) |          |        |       | Meyer (1942) |          |        |       | Brady et al. (1969) |          |        |       | Ryan and Harleman (1973) |          |        |       |         |
|-----------|---------------|----------|--------|-------|--------------|----------|--------|-------|---------------------|----------|--------|-------|--------------------------|----------|--------|-------|---------|
|           | Qe            | E        |        |       | Qe           | E        |        |       | Qe                  | E        |        |       | Qe                       | E        |        |       | Average |
| Month     | [W/m^2]       | [m/s]    | [cm/d] | [in]  | [W/m^2]      | [m/s]    | [cm/d] | [in]  | [W/m^2]             | [m/s]    | [cm/d] | [in]  | [W/m^2]                  | [m/s]    | [cm/d] | [in]  | [in]    |
| January   | 15.1          | 6.07E-09 | 0.02   | 0.64  | 53.5         | 2.15E-08 | 0.07   | 2.27  | 40.4                | 1.62E-08 | 0.06   | 1.71  | 12.5                     | 5.02E-09 | 0.02   | 0.53  | 1.29    |
| February  | 15.9          | 6.37E-09 | 0.02   | 0.61  | 50.1         | 2.01E-08 | 0.07   | 1.92  | 37.4                | 1.50E-08 | 0.05   | 1.43  | 13.1                     | 5.27E-09 | 0.02   | 0.50  | 1.11    |
| March     | 18.0          | 7.21E-09 | 0.02   | 0.76  | 45.2         | 1.82E-08 | 0.06   | 1.92  | 32.9                | 1.32E-08 | 0.04   | 1.39  | 14.8                     | 5.96E-09 | 0.02   | 0.63  | 1.17    |
| April     | 21.6          | 8.70E-09 | 0.03   | 0.89  | 48.8         | 1.97E-08 | 0.07   | 2.01  | 35.1                | 1.42E-08 | 0.05   | 1.44  | 17.9                     | 7.19E-09 | 0.02   | 0.73  | 1.27    |
| May       | 25.6          | 1.03E-08 | 0.04   | 1.09  | 52.3         | 2.11E-08 | 0.07   | 2.23  | 37.4                | 1.51E-08 | 0.05   | 1.59  | 21.2                     | 8.56E-09 | 0.03   | 0.90  | 1.45    |
| June      | 32.1          | 1.30E-08 | 0.04   | 1.33  | 64.9         | 2.63E-08 | 0.09   | 2.68  | 46.4                | 1.88E-08 | 0.06   | 1.92  | 26.5                     | 1.07E-08 | 0.04   | 1.10  | 1.75    |
| July      | 68.6          | 2.79E-08 | 0.09   | 2.94  | 133.3        | 5.43E-08 | 0.18   | 5.72  | 95.2                | 3.88E-08 | 0.13   | 4.09  | 56.7                     | 2.31E-08 | 0.08   | 2.43  | 3.80    |
| August    | 69.0          | 2.81E-08 | 0.10   | 2.96  | 136.8        | 5.57E-08 | 0.19   | 5.87  | 97.8                | 3.98E-08 | 0.14   | 4.20  | 57.1                     | 2.32E-08 | 0.08   | 2.45  | 3.87    |
| September | 38.3          | 1.55E-08 | 0.05   | 1.58  | 79.0         | 3.20E-08 | 0.11   | 3.26  | 56.5                | 2.29E-08 | 0.08   | 2.34  | 31.6                     | 1.28E-08 | 0.04   | 1.31  | 2.12    |
| October   | 15.0          | 6.06E-09 | 0.02   | 0.64  | 35.3         | 1.42E-08 | 0.05   | 1.50  | 25.5                | 1.03E-08 | 0.03   | 1.08  | 12.4                     | 5.01E-09 | 0.02   | 0.53  | 0.94    |
| November  | 11.5          | 4.61E-09 | 0.02   | 0.47  | 37.0         | 1.49E-08 | 0.05   | 1.52  | 27.7                | 1.11E-08 | 0.04   | 1.13  | 9.5                      | 3.81E-09 | 0.01   | 0.39  | 0.88    |
| December  | 13.1          | 5.27E-09 | 0.02   | 0.56  | 48.9         | 1.96E-08 | 0.07   | 2.07  | 37.1                | 1.49E-08 | 0.05   | 1.57  | 10.8                     | 4.36E-09 | 0.01   | 0.46  | 1.16    |
|           |               |          | Total  | 14.47 |              |          | Total  | 32.97 |                     |          | Total  | 23.90 |                          |          | Total  | 11.96 | 20.82   |

Average evaporation from the four methods: 20.82 inches

April - October 15.21  
November - March 5.62

# EVAPORATIVE LOSS IN HEATED OUTDOOR POOL - PROPOSED CONDITIONS, 62 DEGREES F

Four applicable methods as compiled by Helfrich et al. (1982), reported and discussed in Bras (1990)  
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Air temperature: Hailey NWS station, 1893-1988 period  
Relative humidity: Hailey airport station, 2003-2012 period  
Wind speed: Clarendon station, August 2011-October 2012 period

Pond temperature 62 deg F = 16.67 deg C (9999 = same as air)  
a 2500 J/g a,b are coeffs in Le equation: es = saturation vapor pressure at pond surface temperature  
b 2.386 J/g-C Le = a - bT ea = vapor pressure of ambient air  
rho 1.00E+06 g/m^3 rho = density of water

| Month     | Days | Avg air temp [C] | Avg RH (%) | Avg Wind (m/s) | Pond sfc temp [C] | Le [J/g] | es (mb) | ea (mb) |
|-----------|------|------------------|------------|----------------|-------------------|----------|---------|---------|
| January   | 31   | -7.1             | 76         | 0.71           | 16.7              | 2460     | 19.0    | 2.8     |
| February  | 28   | -4.4             | 73         | 0.82           | 16.7              | 2460     | 19.0    | 3.2     |
| March     | 31   | -0.6             | 68         | 1.09           | 16.7              | 2460     | 19.0    | 4.0     |
| April     | 30   | 5.9              | 60         | 1.26           | 16.7              | 2460     | 19.0    | 5.6     |
| May       | 31   | 10.9             | 58         | 1.45           | 16.7              | 2460     | 19.0    | 7.6     |
| June      | 30   | 14.9             | 53         | 1.47           | 16.7              | 2460     | 19.0    | 8.9     |
| July      | 31   | 19.7             | 40         | 1.55           | 16.7              | 2460     | 19.0    | 9.3     |
| August    | 31   | 18.9             | 41         | 1.51           | 16.7              | 2460     | 19.0    | 8.9     |
| September | 30   | 13.7             | 48         | 1.43           | 16.7              | 2460     | 19.0    | 7.6     |
| October   | 31   | 8.1              | 63         | 1.20           | 16.7              | 2460     | 19.0    | 6.8     |
| November  | 30   | 0.6              | 72         | 0.80           | 16.7              | 2460     | 19.0    | 4.6     |
| December  | 31   | -5.4             | 78         | 0.67           | 16.7              | 2460     | 19.0    | 3.2     |

| Month     | Kohler (1954) |          |        |       | Meyer (1942) |          |        |      | Brady et al. (1969) |          |        |      | Ryan and Harleman (1973) |          |        |      | Increase from natural |       |
|-----------|---------------|----------|--------|-------|--------------|----------|--------|------|---------------------|----------|--------|------|--------------------------|----------|--------|------|-----------------------|-------|
|           | Qe [W/m^2]    | E [m/s]  | [cm/d] | [in]  | Qe [W/m^2]   | E [m/s]  | [cm/d] | [in] | Qe [W/m^2]          | E [m/s]  | [cm/d] | [in] | Qe [W/m^2]               | E [m/s]  | [cm/d] | [in] | Average [in]          |       |
| January   | 43.4          | 1.76E-08 | 0.06   | 1.86  | 153.7        | 6.25E-08 | 0.21   | 6.59 | 116.0               | 4.72E-08 | 0.16   | 4.97 | 35.9                     | 1.46E-08 | 0.05   | 1.54 | 3.74                  | 2.45  |
| February  | 48.3          | 1.96E-08 | 0.07   | 1.87  | 152.7        | 6.21E-08 | 0.21   | 5.91 | 113.8               | 4.63E-08 | 0.16   | 4.41 | 39.9                     | 1.62E-08 | 0.06   | 1.55 | 3.43                  | 2.32  |
| March     | 61.2          | 2.49E-08 | 0.08   | 2.62  | 154.1        | 6.26E-08 | 0.21   | 6.61 | 112.0               | 4.55E-08 | 0.15   | 4.80 | 50.6                     | 2.06E-08 | 0.07   | 2.17 | 4.05                  | 2.88  |
| April     | 63.1          | 2.56E-08 | 0.09   | 2.62  | 142.6        | 5.80E-08 | 0.20   | 5.92 | 102.6               | 4.17E-08 | 0.14   | 4.26 | 52.1                     | 2.12E-08 | 0.07   | 2.16 | 3.74                  | 2.47  |
| May       | 61.9          | 2.52E-08 | 0.09   | 2.65  | 126.4        | 5.14E-08 | 0.17   | 5.42 | 90.4                | 3.68E-08 | 0.13   | 3.88 | 51.2                     | 2.08E-08 | 0.07   | 2.19 | 3.54                  | 2.08  |
| June      | 55.2          | 2.24E-08 | 0.08   | 2.29  | 111.7        | 4.54E-08 | 0.15   | 4.63 | 79.8                | 3.24E-08 | 0.11   | 3.31 | 45.7                     | 1.86E-08 | 0.06   | 1.89 | 3.03                  | 1.28  |
| July      | 56.3          | 2.29E-08 | 0.08   | 2.41  | 109.6        | 4.45E-08 | 0.15   | 4.70 | 78.2                | 3.18E-08 | 0.11   | 3.35 | 46.6                     | 1.89E-08 | 0.06   | 2.00 | 3.12                  | -0.68 |
| August    | 57.1          | 2.32E-08 | 0.08   | 2.45  | 113.2        | 4.60E-08 | 0.16   | 4.85 | 80.9                | 3.29E-08 | 0.11   | 3.47 | 47.2                     | 1.92E-08 | 0.07   | 2.02 | 3.20                  | -0.67 |
| September | 60.7          | 2.47E-08 | 0.08   | 2.52  | 125.4        | 5.10E-08 | 0.17   | 5.20 | 89.7                | 3.65E-08 | 0.12   | 3.72 | 50.2                     | 2.04E-08 | 0.07   | 2.08 | 3.38                  | 1.26  |
| October   | 54.5          | 2.21E-08 | 0.08   | 2.33  | 127.9        | 5.20E-08 | 0.18   | 5.48 | 92.3                | 3.75E-08 | 0.13   | 3.96 | 45.0                     | 1.83E-08 | 0.06   | 1.93 | 3.43                  | 2.49  |
| November  | 43.1          | 1.75E-08 | 0.06   | 1.79  | 139.1        | 5.66E-08 | 0.19   | 5.77 | 103.9               | 4.22E-08 | 0.14   | 4.31 | 35.6                     | 1.45E-08 | 0.05   | 1.48 | 3.34                  | 2.46  |
| December  | 39.7          | 1.62E-08 | 0.05   | 1.70  | 148.0        | 6.02E-08 | 0.20   | 6.34 | 112.4               | 4.57E-08 | 0.16   | 4.82 | 32.9                     | 1.34E-08 | 0.05   | 1.41 | 3.57                  | 2.40  |
| Total     |               |          |        | 27.12 | Total        |          |        |      | Total               |          |        |      | Total                    |          |        |      | 41.55                 | 20.73 |

Average evaporation from the four methods: 41.55 inches

April - October 23.43 8.22  
November - March 18.13 12.51

# **EVAPORATIVE LOSS IN HEATED OUTDOOR "PLUNGE" POOL - PROPOSED CONDITIONS, 85 DEGREES F**

Four applicable methods as compiled by Helfrich et al. (1982), reported and discussed in Bras (1990)  
CGB REVISED 1/30/2013

Air temperature: Hailey NWS station, 1893-1988 period  
Relative humidity: Hailey airport station, 2003-2012 period  
Wind speed: Clarendon station, August 2011-October 2012 period

Pond temperature 85 deg F = 29.44 deg C (9999 = same as air)  
a 2500 J/g a,b are coeffs in Le equation: es = saturation vapor pressure at pond surface temperature  
b 2.386 J/g-C Le = a - bT ea = vapor pressure of ambient air  
rho 1.00E+06 g/m^3 rho = density of water

| Month     | Days | Avg air temp [C] | Avg RH (%) | Avg Wind (m/s) | Pond sfc temp [C] | Le [J/g] | es (mb) | ea (mb) |
|-----------|------|------------------|------------|----------------|-------------------|----------|---------|---------|
| January   | 31   | -7.1             | 76         | 0.71           | 29.4              | 2430     | 41.1    | 2.8     |
| February  | 28   | -4.4             | 73         | 0.82           | 29.4              | 2430     | 41.1    | 3.2     |
| March     | 31   | -0.6             | 68         | 1.09           | 29.4              | 2430     | 41.1    | 4.0     |
| April     | 30   | 5.9              | 60         | 1.26           | 29.4              | 2430     | 41.1    | 5.6     |
| May       | 31   | 10.9             | 58         | 1.45           | 29.4              | 2430     | 41.1    | 7.6     |
| June      | 30   | 14.9             | 53         | 1.47           | 29.4              | 2430     | 41.1    | 8.9     |
| July      | 31   | 19.7             | 40         | 1.55           | 29.4              | 2430     | 41.1    | 9.3     |
| August    | 31   | 18.9             | 41         | 1.51           | 29.4              | 2430     | 41.1    | 8.9     |
| September | 30   | 13.7             | 48         | 1.43           | 29.4              | 2430     | 41.1    | 7.6     |
| October   | 31   | 8.1              | 63         | 1.20           | 29.4              | 2430     | 41.1    | 6.8     |
| November  | 30   | 0.6              | 72         | 0.80           | 29.4              | 2430     | 41.1    | 4.6     |
| December  | 31   | -5.4             | 78         | 0.67           | 29.4              | 2430     | 41.1    | 3.2     |

| Month     | Kohler (1954) |          |        |       | Meyer (1942) |          |        |       | Brady et al. (1969) |          |        |       | Ryan and Harleman (1973) |          |        |      | Increase from natural |       |
|-----------|---------------|----------|--------|-------|--------------|----------|--------|-------|---------------------|----------|--------|-------|--------------------------|----------|--------|------|-----------------------|-------|
|           | Qe [W/m^2]    | E [m/s]  | [cm/d] | [in]  | Qe [W/m^2]   | E [m/s]  | [cm/d] | [in]  | Qe [W/m^2]          | E [m/s]  | [cm/d] | [in]  | Qe [W/m^2]               | E [m/s]  | [cm/d] | [in] | Average [in]          |       |
| January   | 102.5         | 4.22E-08 | 0.14   | 4.45  | 362.9        | 1.49E-07 | 0.51   | 15.75 | 274.0               | 1.13E-07 | 0.38   | 11.89 | 84.8                     | 3.49E-08 | 0.12   | 3.68 | 8.94                  | 7.66  |
| February  | 116.1         | 4.78E-08 | 0.16   | 4.55  | 367.1        | 1.51E-07 | 0.51   | 14.39 | 273.5               | 1.13E-07 | 0.38   | 10.72 | 96.0                     | 3.95E-08 | 0.13   | 3.76 | 8.36                  | 7.24  |
| March     | 151.6         | 6.24E-08 | 0.21   | 6.58  | 381.8        | 1.57E-07 | 0.53   | 16.57 | 277.4               | 1.14E-07 | 0.39   | 12.04 | 125.3                    | 5.16E-08 | 0.18   | 5.44 | 10.16                 | 8.98  |
| April     | 167.4         | 6.89E-08 | 0.23   | 7.03  | 378.4        | 1.56E-07 | 0.53   | 15.89 | 272.3               | 1.12E-07 | 0.38   | 11.43 | 138.4                    | 5.69E-08 | 0.19   | 5.81 | 10.04                 | 8.77  |
| May       | 181.8         | 7.48E-08 | 0.25   | 7.89  | 371.4        | 1.53E-07 | 0.52   | 16.12 | 265.6               | 1.09E-07 | 0.37   | 11.53 | 150.3                    | 6.19E-08 | 0.21   | 6.52 | 10.51                 | 9.06  |
| June      | 176.9         | 7.28E-08 | 0.25   | 7.43  | 357.6        | 1.47E-07 | 0.50   | 15.02 | 255.7               | 1.05E-07 | 0.36   | 10.74 | 146.2                    | 6.02E-08 | 0.20   | 6.14 | 9.83                  | 8.08  |
| July      | 184.9         | 7.61E-08 | 0.26   | 8.03  | 359.6        | 1.48E-07 | 0.50   | 15.61 | 256.8               | 1.06E-07 | 0.36   | 11.15 | 152.9                    | 6.29E-08 | 0.21   | 6.64 | 10.35                 | 6.56  |
| August    | 182.3         | 7.50E-08 | 0.26   | 7.91  | 361.3        | 1.49E-07 | 0.51   | 15.68 | 258.1               | 1.06E-07 | 0.36   | 11.20 | 150.7                    | 6.20E-08 | 0.21   | 6.54 | 10.33                 | 6.46  |
| September | 178.9         | 7.36E-08 | 0.25   | 7.51  | 369.3        | 1.52E-07 | 0.52   | 15.51 | 264.2               | 1.09E-07 | 0.37   | 11.10 | 147.9                    | 6.09E-08 | 0.21   | 6.21 | 10.08                 | 7.96  |
| October   | 153.5         | 6.32E-08 | 0.21   | 6.66  | 360.6        | 1.48E-07 | 0.50   | 15.65 | 260.3               | 1.07E-07 | 0.36   | 11.30 | 126.9                    | 5.22E-08 | 0.18   | 5.51 | 9.78                  | 8.84  |
| November  | 109.1         | 4.49E-08 | 0.15   | 4.58  | 352.5        | 1.45E-07 | 0.49   | 14.80 | 263.3               | 1.08E-07 | 0.37   | 11.06 | 90.2                     | 3.71E-08 | 0.13   | 3.79 | 8.56                  | 7.68  |
| December  | 95.4          | 3.93E-08 | 0.13   | 4.14  | 355.3        | 1.46E-07 | 0.50   | 15.42 | 269.8               | 1.11E-07 | 0.38   | 11.71 | 78.9                     | 3.25E-08 | 0.11   | 3.42 | 8.67                  | 7.51  |
| Total     |               |          |        | 76.77 | Total        |          |        |       | Total               |          |        |       | Total                    |          |        |      | 115.62                | 94.80 |

Average evaporation from the four methods: 115.62 inches

April - October 70.94 55.73  
November - March 44.69 39.07

# SUN VALLEY LAND & MINERALS PERMIT 37-8205 MITIGATION PLAN

## SUMMARY OF POND EVAPORATION CALCULATIONS

Brockway Engineering REVISED 1/30/2013

### HEATED POND

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|                                        | Area<br>[acres] | Evap<br>[in/yr] | Evap<br>[ac-ft/yr] |
|----------------------------------------|-----------------|-----------------|--------------------|
| Heated plunge area 25'x25' at 85 deg F | 0.01            | 115.6           | 0.14               |
| Main pond at 62.5 deg F                | 1.16            | 41.6            | 4.02               |
| <b>Total evaporation - heated pond</b> |                 |                 | <b>4.15</b>        |

### NATURAL COLD WATER POND

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|                                            |                      |
|--------------------------------------------|----------------------|
| Natural cold water evaporation             | 20.82 in/year        |
| Area of pond                               | 1.17 acres           |
| <b>Total evaporation - cold water pond</b> | <b>2.03 ac-ft/yr</b> |

**Increase in evaporation**                      **2.12 ac-ft/yr**

## SUN VALLEY LAND & MINERALS

### OPEN POND HEAT LOSS - MONTHLY & ANNUAL VOLUME REQUIREMENT

Permit 37-8205

CGB 11/16/2010 - Reduced Heat Load for Mitigation Plan

CGB 1/30/2012 - REVISED, new met data

Average climatic conditions

Resource temperature 124.7 F

Target pond temperature: 62.5F (main pond), 85F (plunge)

| Month        | No. Days | Wind<br>Speed (1) | Air<br>Temp (2) | Relative<br>Humid (3) | Average flow<br>requirement (4) | Volume (ac-ft) |
|--------------|----------|-------------------|-----------------|-----------------------|---------------------------------|----------------|
| January      | 31       | 2.62              | 19.3            | 76                    | 153.6                           | 21.0           |
| February     | 28       | 3.24              | 24.1            | 73                    | 156.8                           | 19.4           |
| March        | 31       | 3.17              | 31.0            | 68                    | 135.2                           | 18.5           |
| April        | 30       | 4.09              | 42.6            | 60                    | 115.8                           | 15.4           |
| May          | 31       | 4.02              | 51.7            | 58                    | 80.3                            | 11.0           |
| June         | 30       | 4.29              | 58.8            | 53                    | 56.4                            | 7.5            |
| July         | 31       | 3.36              | 67.5            | 40                    | 21.0                            | 2.9            |
| August       | 31       | 3.59              | 66.0            | 41                    | 28.6                            | 3.9            |
| September    | 30       | 3.43              | 56.7            | 48                    | 58.6                            | 7.8            |
| October      | 31       | 3.21              | 46.5            | 63                    | 86.2                            | 11.8           |
| November     | 30       | 2.22              | 33.0            | 72                    | 107.1                           | 14.2           |
| December     | 31       | 2.83              | 22.3            | 78                    | 150.7                           | 20.6           |
| <b>TOTAL</b> |          |                   |                 |                       |                                 | <b>154.0</b>   |

(1) Average monthly wind speed at Clarendon weather station [mph]  
estimated from Hailey-KSUN station using regression equation

(2) Average monthly temperature at Hailey NWS [degrees F]

(3) Average monthly relative humidity at Hailey airport [%]

(4) Estimated on separate spreadsheet by OIT GeoHeat Center tool [gpm]

## OPEN POND HEAT LOSS CALCULATION - PEAK FLOW REQUIREMENT

CGB 1/30/2013 - REVISED, new met data

**Total - plunge and pond**                      **164 gpm**  
**0.37 cfs**

## SUN VALLEY LAND & MINERALS

### OPEN POND HEAT LOSS CALCULATION - PEAK FLOW REQUIREMENT

Permit 37-8205

OIT Geoheat Center Tools

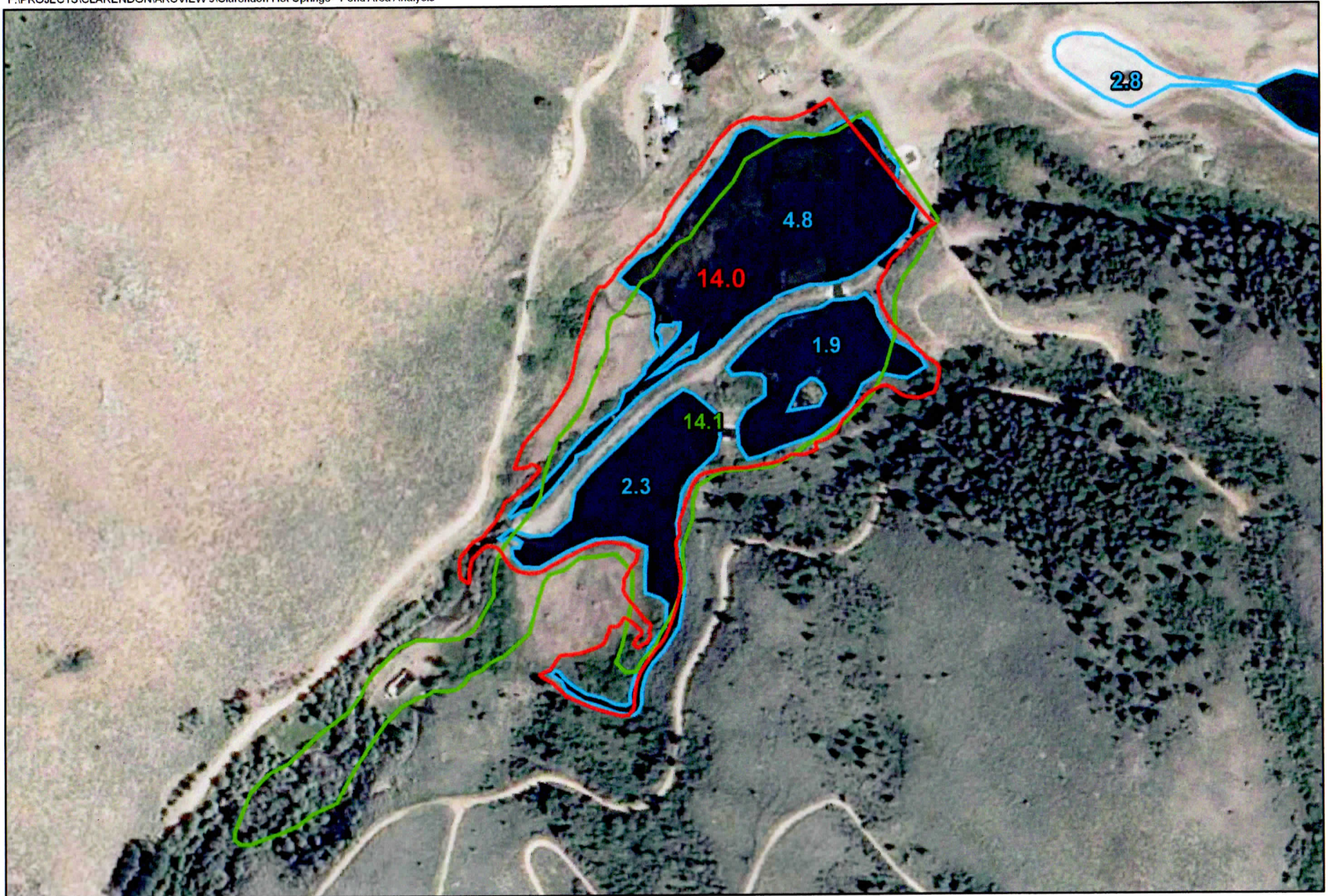
CGB 11/16/2010 - Reduced Heat Load for Mitigation Plan

CGB 1/30/2013 - REVISED, new met data

#### HEATED "PLUNGE" AREA - 85 DEGREES F

| Parameter                     | Value  | Units            | Assumptions / Remarks                               |
|-------------------------------|--------|------------------|-----------------------------------------------------|
| 1. Resource temp              | 124.7  | F                | Measured mixed temperature 10/13/09                 |
| 2. Length                     | 25     | ft               | Pond length avg                                     |
| 3. Width                      | 25     | ft               | Pond width avg                                      |
| 4. Water temp in pond         | 85     | F                | Pleasant temperature for bathing/swimming           |
| 5. Wind velocity              | 1.6    | mph              | Average January at Clarendon, predicted with Hailey |
| 6. Air temp                   | -1.7   | F                | 80% exceedance minimum Jan temp at Hailey           |
| 9. Relative humidity          | 78.0   | %                | Average January humidity at Hailey airport          |
| 7. Cover thickness            | 0      | in               | No pond cover                                       |
| 8. Cover "k"                  | 0.4    | btu in/hr sqft F | Value irrelevant since thickness = 0                |
| 10. Calculated water vap pres | 0.589  | psia             |                                                     |
| 1. Evaporative Loss           | 36491  | btu/hr           | 58.4 btu/hr sqft                                    |
| 2. Convective Loss            | 32712  | btu/hr           | 52.3 btu/hr sqft                                    |
| 3. Radiant Loss               | 44609  | btu/hr           | 71.4 btu/hr sqft                                    |
| 4. Conductive Loss            | 8066   | btu/hr           | 12.9 btu/hr sqft                                    |
| 5. Total Loss                 | 121879 | btu/hr           | 195.0 btu/hr sqft                                   |
| 6. Required flow rate         | 6.1    | gpm              |                                                     |

|           |         |                   |                     |
|-----------|---------|-------------------|---------------------|
| ha        | 0.60369 | Pond surface area | 625 ft <sup>2</sup> |
| x/k       | 0       |                   | 0.01 acres          |
| p. press  | 0.024   |                   |                     |
| area      | 625     |                   |                     |
| surf temp | 85      |                   |                     |
| U         | 0.60369 |                   |                     |

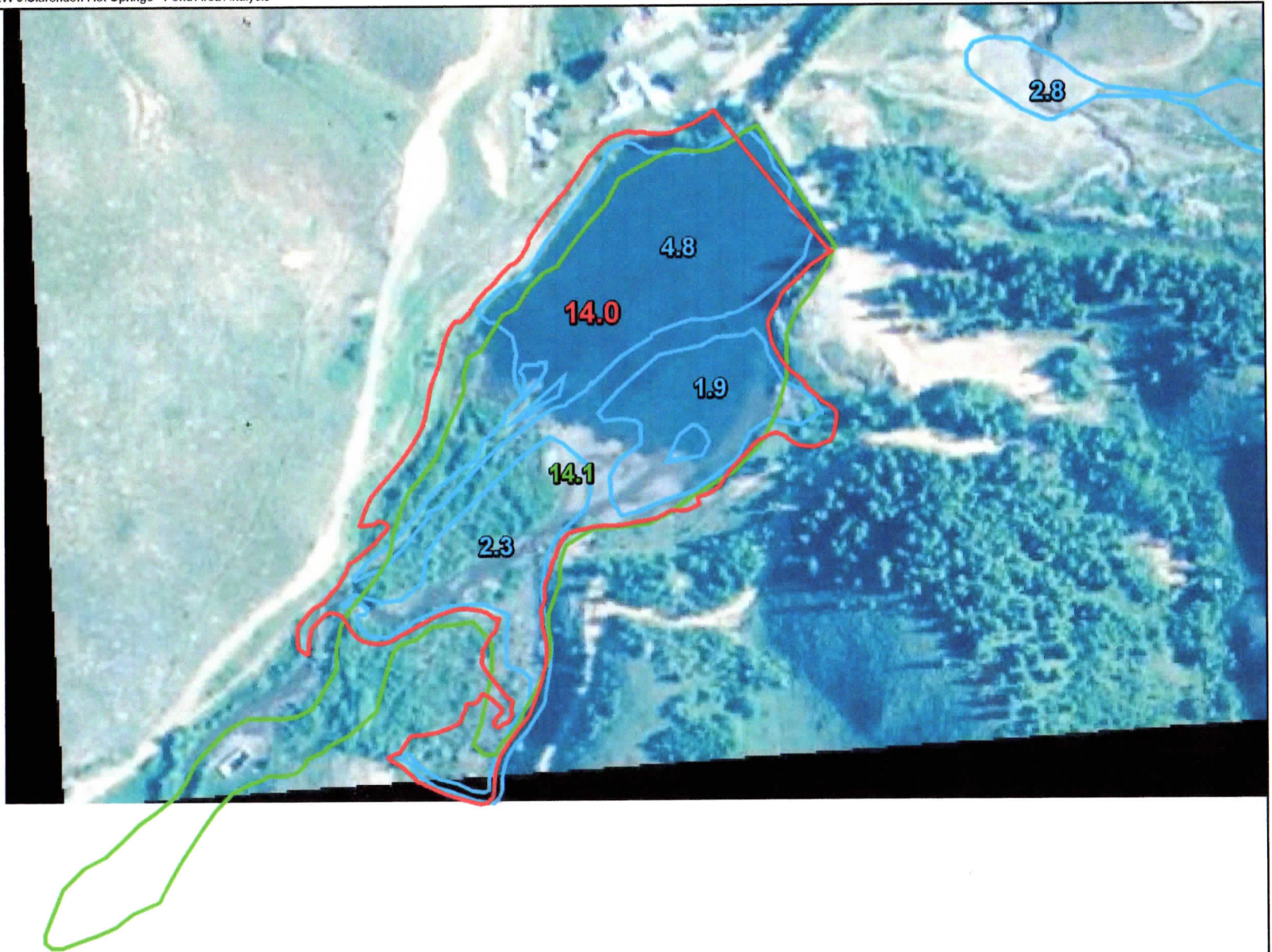


1 inch equals 300 feet

**SUN VALLEY LAND & MINERALS  
HISTORIC RESERVOIR AREAS  
NAIP 2009 AERIAL**

**Legend**

- 5631' CONTOUR MAY 2000
- USGS Quad Reservoir
- Current Ponds



1 inch equals 300 feet

**SUN VALLEY LAND & MINERALS  
HISTORIC RESERVOIR AREAS  
FSA 1980 AERIAL PHOTOGRAPH**

**Legend**

- 5631' CONTOUR MAY 2000
- USGS Quad Reservoir
- Current Ponds